

representing the fin. The length of the strip of paper in centimetres gives, with approximate accuracy, the size of the fin-surface in square centimetres. The sizes so obtained are probably too small, for it is not possible to spread out to its fullest extent the fin of a fish that has been preserved in alcohol. The surface of the two pectoral fins of *Exocoetus* as thus computed was 38.4 square centimetres, whereas the corresponding area in the case of *Hemirhamphus* was 3.9 square centimetres. That is to say, the superficial area of the pectoral fins of *Exocoetus* is some eight or nine times that of the corresponding surface in a *Hemirhamphus* of the same size, whereas the weight of the external pectoral muscles is only twice.

As an item of negative evidence, it may be of interest to state that a microscopical examination was made of dissociated fibres of the external pectoral muscles of *Gastropolecus stellatus*, *Tetragonopterus aeneus*, *Exocoetus evolans*, and *Hemirhamphus roberti*, in order to ascertain if in the "flying" form the cross-stripping of the muscle-fibres was more pronounced than in the control species. The fibres, after being teased, were stained, some with picric-acid-fuchsin (van Gieson's stain), some with borax-carminic; some were examined in diluted glycerine, some in Canada balsam. Examination of these slides failed to show any marked differences in the degree of cross-stripping.

In conclusion, I have to thank Dr. S. F. Harmer, F.R.S., Keeper of the Department of Zoology in the British Museum, and Mr. C. Tate Regan, M.A., Assistant in charge of the Fishes, for providing me with the specimens upon which the observations recorded above were made.

EXPLANATION OF PLATE XVI.

Photograph of a skeleton of *Gastropolecus stellatus* ($\times \frac{3}{4}$). Note the great radially corrugated keel of bone, to the right and left sides of which are attached the external pectoral muscles, which pull down the fins.

LXVIII.—*Phallostethus dunckeri*, a remarkable new
Cyprinodont Fish from Johore. By C. TATE REGAN, M.A.

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IN 1904 (Mitteil. Naturhistorisch. Mus. Hamburg, xxi. pp. 135-207) Dr. G. Duncker published a memoir on the Fishes of the Malay Peninsula, and on page 171 mentioned

a new Cyprinodont in the following words:—"Die beschreibung zweier weiterer, einer neuen Gattung mit gekieltem Abdomen, hinter der A. befindlicher D., gegabelter C. und fehlenden V. angehörigen Arten dieser Familie behalte Ich für später vor. Beide gehören dem Brackwasser an (Kuala Langat, Muar-Flusz bei Bandar Maharani)."

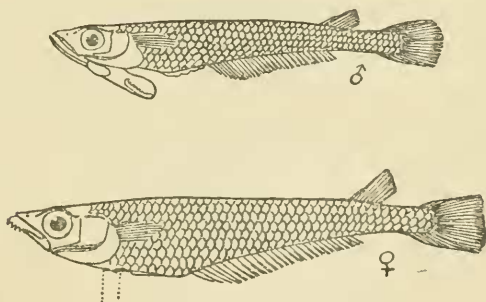
A few months ago Dr. Duncker visited the British Museum to study our Syngnathidæ, and I then asked him whether he had published anything further concerning these fishes, whereon he kindly offered to send me some of them for description, as he was engaged in other work.

The specimens prove to belong to a new genus and species, which is so different from other known Cyprinodonts that it should perhaps rank as the type of a separate subfamily.

PHALLOSTETHUS, gen. nov.

Form elongate, compressed; scales moderate; vent thoracic. Mouth protractile, oblique, with the horseshoe-shaped lower jaw included within the shovel-shaped upper one; teeth conical, biserial; outer series of upper jaw curved, rather strong, especially the anterior lateral ones; outer series of lower jaw nearly horizontal. Dorsal fin short,

Fig. 1.



Phallostethus dunckeri, male and female, a little more than twice natural size.

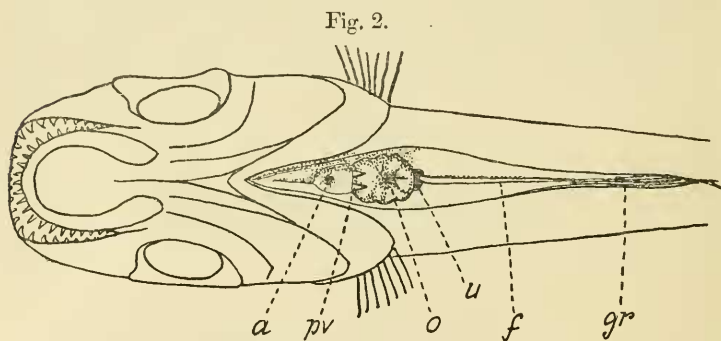
originating above end of the long anal; in front of the latter a median dermal fold placed in a groove. Female with pelvic fins minute, below the pectorals, between vent and opening of oviduct. Male with a large muscular appendage attached between the expanded hypocoracoids and free distally, bearing the vent on one side at about the middle of its

length and the genital opening at its posterior end, just behind the articulation of an external movable, forwardly directed, serrated bone; anteriorly the appendage ends in a long slender bone extending forwards to beneath the chin, curved towards the side on which the serrated bone lies and away from that on which the vent opens.

Phallostethus dunckeri, sp. n.

The form and proportions are shown by the accompanying figures. I count 8 to 10 dorsal and 26 to 28 anal rays; the caudal fin is imperfect in all, so that its exact shape is uncertain; there are about 40 scales in a longitudinal series, and they appear to correspond to the myotomes, so that the vertebræ number about 40. Of seven specimens (three males and four females) the largest male measures 25 mm., the largest female 29 mm. in total length.

The external features of the lower surface of the head and abdomen in the female fish are illustrated in fig. 2. A flattish



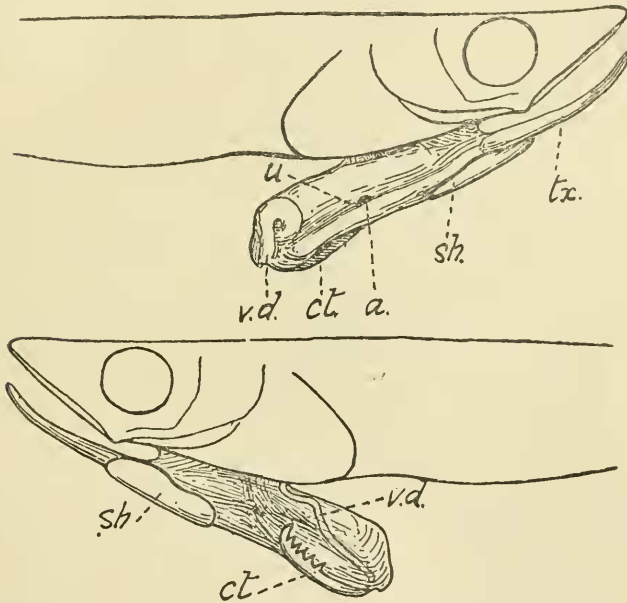
Phallostethus dunckeri, head and abdomen of female from below ($\times 8$).

a., anus; *pv.*, pelvic fin; *o.*, opening of oviduct; *u.*, urinary opening; *f.*, dermal fringe; *gr.*, groove.

median naked area margined anteriorly by the lower edges of the hypocoracoids expands backwards and contains successively the vent, a pair of almost vestigial pelvic fins, the genital and urinary apertures; from the last a low median keel runs backwards. Behind the opening of the oviduct the naked area contracts, and it becomes a groove, which extends to the origin of the anal fin, becoming narrower and deeper posteriorly; the walls of the groove are supported by the ends of the seven pairs of ribs.

The male (fig. 3) differs from the female externally in that the median keel is more developed as a membranous fringe and in front of it the very deep groove extends forwards, being margined anteriorly by the strongly expanded hypocoracoids, from between which there projects downwards and backwards a large fleshy appendage, oblong in form and laterally compressed, which may be termed the *priapium*; at the posterior end of this can be seen the opening of the vas deferens, and at about the middle of its length, on one side, hereafter termed the "proctal" side, the vent, directly behind which is the urinary opening. At the anterior end is a long and

Fig. 3.



Phallostethus dunckeri, male, showing external features of the priapium from the proctal and the aproctal side ($\times 8$).

tr., toxactinium; *ct.*, ctenactinium; *sh.*, shield of thick skin; *v.d.*, vas deferens; *a.*, anus; *u.*, opening of ureter. The two last lie in a slight groove which indicates the boundary between the dorsal and ventral muscles.

slender bony spine, rounded in cross-section, tapering forward beneath the clin, and curved away from the proctal side; this rod may be termed the *toxactinium*; it can be moved

laterally or downwards to a certain extent; its articulation with the priapium is covered by a large rounded shield of thick skin, placed ventrally, but much more developed upwards on the aproctal side. At the posterior end just below the genital opening is articulated another bony spine, which seems to be freely movable outwards and may be termed the *ctenactinium*; when at rest this is directed forwards and lies on the aproctal side of the priapium; it is laterally compressed, is straight, with the distal end somewhat curved upwards and ending in a pointed denticulation, and it bears five other somewhat smaller denticulations on its upper edge.

The skeleton seems to be typically Cyprinodont*; the vertebræ number about 40 (9+31) and there are seven pairs of ribs inserted on transverse processes. The minute pelvic fins of the female are supported by a correspondingly minute pair of pelvic bones.

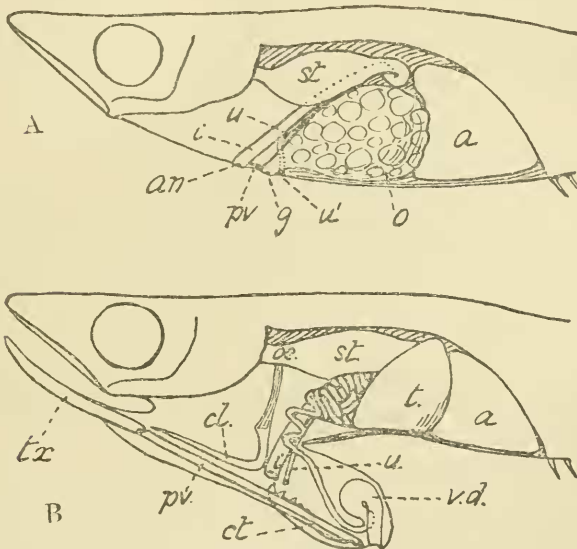
In the female (fig. 4, A) the visceral anatomy shows but little departure from the structure seen in carnivorous Fundulinae, except for modifications due to the anterior position of the vent and of the openings of the urinary and genital ducts. The large air-bladder is placed posteriorly; the stomach is a simple expansion of the alimentary canal, without caeca, and from it the intestine runs straight back on the left side to the air-bladder, turns downward and crosses above the ovary to the right side, and then runs straight downwards and forwards to the anus; the liver is large. The ureters arise close together from the posterior end of the kidney, which seems to be unpaired; they unite to form a single duct, which runs downwards and forwards below the intestine on the right side of the ovary and across below the latter to the urinary opening. The ovary is unpaired, as in many other Cyprinodonts; it is a pyriform organ that lies in front of the air-bladder and occupies the whole width of the body; it narrows anteriorly and opens almost directly to the exterior, there being practically no oviduct.

In the male (fig. 4, B) the unpaired testis is very similar in form to the ovary, but is shorter and deeper and does not extend so far forward; the vas deferens leaves it anteriorly and immediately becomes closely coiled up into a mass that lies in front and to the right side of the testis, and is rather similar in form but less in bulk than the latter; within this mass

* In order to investigate the structure I had series of sections made of the anterior half of the body in two specimens (♂ and ♀); these were of great assistance in making clear certain features that could not be made out by ordinary dissection.

the walls of the duct are thick and glandular, and from its narrowed anterior end it emerges and runs with one or two loops into the priapium at the posterior end of its junction with the body, and then backwards and downwards near the surface of the aproctal side of the priapium to above the base of the ctenactinium, when it passes to the proctal side and coils round in a complete circle before opening to the exterior; this terminal coil has very thick muscular walls.

Fig. 4.



Phallostethus dunckeri. Dissection of female and male (partly reconstructed). The pectoral arch and muscles of the left side have been removed; also the liver, which occupies nearly all the space between oesophagus and intestine and almost surrounds the stomach.

œ., oesophagus; st., stomach; i., intestine; an., anus; a., air-bladder; u., ureter; u.', urinary opening; o., ovary; g., opening of oviduct; t., testis; v.d., vas deferens; pv., pelvis; cl., priapial process of cleithra.

The intestine enters the priapium a little in front of the vas deferens and runs downwards and obliquely across to the anus; the kidney-duct accompanies the intestine and opens to the exterior just behind it.

Immediately in front of the intestine a bony process runs downwards from the cleithral symphysis to just in front of the vent, and is produced forwards as a bony rod that forms a

skeletal support for the priapium ; it tapers anteriorly and extends on the proctal side nearly to the anterior end. A mid-ventral rod of bone runs the whole length of the priapium ; the toxactinium articulates with its anterior end, the ctenactinium with its posterior end ; it seems probable that these are modified pelvic fin-rays and that the bony rod with which they articulate is the pelvis. The last-named lies between a pair of longitudinal muscles which also run the whole length of the organ and are more or less symmetrically arranged except in the region of the anus, where they send out a dorsal branch that runs on the aproctal side of the priapium right up into the body and is attached high up on the inner side of the cleithrum of the proctal side. The anal and urinary openings and in front of them the prolongation of the cleithra mentioned above lie directly above these ventral muscles. A pair of dorsal muscles also run the whole length of the priapium, lying nearly symmetrically and directly above the ventral muscles except in two regions : (1) the region of the anus, where the cleithral process and the intestine separate them from the ventral muscles and with the cleithral branch of the latter displace them towards the proctal side ; (2) the region of the terminal coil of the vas deferens ; here the dorsal muscles unite, taper, and are confined to the aproctal side.

The pectoral muscles attached to the expanded hyporacoids are continued forward into the dorsal part of the priapium, tapering anteriorly and ending above the base of the toxactinium.

It is evident that the priapium is an intromittent organ. Probably its distal end is brought close against or just within the genital aperture of the female, and the ctenactinium is used to hold it in position ; the toxactinium may also assist in this ; the dorsal and ventral longitudinal muscles of the priapium are probably concerned chiefly with the movement of these two bony appendages. Contraction of the cleithral branch of the ventral priapial muscles would doubtless bring the distal part of the organ nearer the body, whilst the reverse effect would be produced by contraction of the pectoral muscles that pass into it anteriorly. The great length of the vas deferens may be due to the need for the plentiful supply of a glandular secretion in which the spermatozoa may live.

It is very remarkable that this little fish should have developed so complex an organ for the purpose of internal fertilization. The whole structure of the priapium is quite unlike that of any other copulatory organ known among fishes, and I believe that the coiling of the vas deferens to form a

sort of epididymis is also unique, as well as the wide separation of the openings of the urinary and genital ducts. No doubt the remoteness of the genital orifice from the anal fin has precluded the use of the latter as an intromittent organ, as is done in the viviparous groups of the family; in this case there is no evidence as to whether the fish is viviparous or not.

LXIX.—Description of a new Loricariid Fish of the Genus *Plecostomus* from Rio Janeiro. By C. TATE REGAN, M.A.

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Plecostomus rachovi, sp. n.

Depth of body 5 in the length, length of head $3\frac{1}{5}$. Depth of head $1\frac{3}{4}$ in its length, breadth $1\frac{1}{4}$, length of snout $1\frac{7}{8}$, diameter of eye 8, interorbital width $2\frac{2}{5}$. Length of mandibular ramus 3 in interorbital width; in either jaw 20 to 22 teeth on each side. Snout ovate; supraorbital edges not elevated; temporal plates weakly carinate; occipital process well developed, somewhat acutely pointed, with a low median ridge; posteriorly it is bordered by several scutes. 32 scutes in a longitudinal series, 8 or 9 between dorsal and adipose fin, 15 between anal and caudal; upper and anterior scutes weakly carinate; lower surface of head and body covered with granular scales. Dorsal I 7; first ray a little longer than head, when laid back reaching seventh scute behind last, which is $\frac{1}{2}$ as long. Anal I 4. Pectoral spine reaching anterior $\frac{1}{4}$ of pelvis. Caudal emarginate. Caudal peduncle $3\frac{1}{3}$ as long as deep. Body with dark spots, about one on each scute; spots on head smaller and more numerous; fins with several transverse bars or series of spots.

A single specimen, 135 mm. in total length, from near Rio Janeiro, presented to the British Museum by Herr A. Rachow.

This resembles *P. laplate*, Eigenm. (*P. tæniatus*, Regan), from the La Plata, in the large number of scutes, in having the occipital process bordered by several, in the rather small eye, &c. It differs in the narrower snout and smaller mouth, broader interorbital region, longer and more pointed occipital process, keeled anterior scutes, higher dorsal fin, and caudal fin barred instead of plain.